

**Instructions:** Upload LEGIBLE, COMPLETE solutions to Gradescope before 11:59pm on 22 October 2021.

1. Compute the direction of maximum increase of  $f(x, y, z) = \frac{x}{y+z}$  at the point  $p = (-1, 3, -1)$ .
2. Classify the critical points of each of the following functions.
  - (a)  $f(x, y) = x^2 + y^4 + 2xy$
  - (b)  $f(x, y) = x^3 + y^3 - 3x^2 - 3y^2 - 9x$
3. Compute the global extrema of  $f(x, y) = x + y - xy$  on the triangular region with vertices  $(0, 0)$ ,  $(0, 2)$ , and  $(4, 0)$ .
4. Compute the global extrema of  $f(x, y, z) = xy^2z$  subject to the constraint  $x^2 + y^2 + z^2 = 4$ .
5. Compute each of the following integrals.
  - (a)  $\iint_D y \exp(-xy) \, dA$  where  $D = [0, 2] \times [1, 3]$
  - (b)  $\iint_D y \sqrt{x^2 - y^2} \, dA$  where  $D$  is the triangle with vertices  $(0, 0)$ ,  $(2, 0)$ , and  $(2, 2)$
  - (c)  $\iint_D \frac{y^2}{x^2 + y^2} \, dA$  where  $D$  lies between the circles  $x^2 + y^2 = 1$  and  $x^2 + y^2 = 16$